

CONSTRUCTION

A Report on the Industry

June 2004

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ABSTRACT

This paper captures a comprehensive five-month study of the construction industry. It seeks to define the industry and identifies current conditions and industry trends. It reviews several challenges confronting the industry and examines the role of government in shaping its future and overcoming these obstacles. Three essays provide a deeper examination of several issues relevant to the industry today.

The highly competitive construction industry is a powerful engine for the U.S. economy, providing strength and stability to our national Gross Domestic Product (GDP). A healthy construction industry creates jobs, fuels the economy, enhances the quality of life for Americans, and is an essential component of our national security.

In 2003, construction continued to track its performance as a generally healthy and moderately profitable industry. The construction industry grew at a moderate pace in the last year in despite a weakening economy and chronic shortages of skilled and semi-skilled labor. The economic stimulus package, a rebounding economy, and continued low interest rates fueled unprecedented increases in housing construction and helped stimulate modest commercial construction. Value in the industry remains strong with projections for limited growth prospects domestically and potentially significant opportunities in the international sector.

Industry data shows evidence of a continuing trend toward consolidation through acquisitions and mergers, forcing smaller construction-related companies to increase their productivity to remain competitive. This trend is driving an accelerated use of information technology tools to improve efficiency. As state and local governments find it increasingly difficult to raise revenues to build and maintain needed infrastructure, alternative financing mechanisms involving private financing of public infrastructure are becoming more widespread.

Challenges facing the industry include a shortage of skilled labor, the rising cost and availability of insurance, a shortage of critical materials, and growing constraints on funding for public infrastructure projects and research and development. Despite these challenges, the industry is poised to support national security objectives and is capable of surging to meet critical national security needs.

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PLACES VISITED

Domestic:

Massachusetts Turnpike Authority, Boston, Massachusetts
Boston Harbor – Central Artery Tunnel Project, MTA, Boston, Massachusetts
Parsons-Brinkerhoff, New York, New York
World Trade Center, New York City, New York
Port Authority of New York, New York, New York
American Subcontractors Association, Alexandria, Virginia
National Association of Homebuilders, Washington, D.C.
United States Capitol Visitor Center Project, Washington D.C.
General Services Administration, Washington, D.C.
American Society of Civil Engineers, Washington D.C.
Associated General Contractors of America, Alexandria, Virginia
Pentagon Renovation Project, Arlington, Virginia
Virginia DoT, Springfield Interchange Project, Springfield, VA
Sheet Metal Workers Union, Local 100, Suitland, Maryland
Stromberg Sheet Metal Works, Beltsville, Maryland
Department of Transportation and Tres Urbano Subway Project, San Juan, Puerto Rico
U.S. Corps of Engineers, San Juan, Puerto Rico
U.S. Corps of Engineers, Mobile District, Alabama, Alabama
Eglin Air Force Base Climatic Testing Facility, Eglin Air Force Base, Florida

Military Medical Facility, Hurlburt Air Force Base, Florida
Greater Jacksonville Municipal Authority, Jacksonville, Florida

International:

U.S. Embassy, Bangkok, Thailand
American Chamber of Commerce, Bangkok Thailand
Royal Thai Navy, dry dock and port construction, Bangkok, Thailand
Metropolitan Rapid Transit Authority, Bangkok Thailand
Laem Chabang Port Authority, Laem Chabang, Thailand

CENTRAIR (Central Japan International Airport), Nagoya, Japan
Bullet Train, Tokyo to Nagoya, Japan
Yokuska Naval Base, Yokuska, Japan
Army Corps of Engineers, Japan District, Yokuska, Japan

Maglev transit system, Shanghai, China
Three Gorges Dam, Yichang, China

INTRODUCTION

The construction industry builds the public and private infrastructure that provides the foundation for our economic and military elements of national power. This study seminar completed a broad-based review of this vital industry by learning from guest lectures, conducting research and study, and visiting construction sites in the continental U.S., Puerto Rico, and Asia. Representatives from construction contractors, trade unions, professional associations, research institutions, U.S. and foreign governments who provided seminar members a wide range of perspectives on the competitive conditions, challenges, and trends of the industry. Seminar members gained valuable, first-hand insight into the complex issues and challenges facing the industry during visits to construction and infrastructure mega project sites.

This study describes the current condition of the American construction industry, assesses the challenges facing the industry, and make recommendations for future actions. Individual essays address emerging issues associated with information technology, Iraq construction, and materials shortages. While not without its challenges, the construction industry remains well positioned to continue to support our national security objectives.

THE INDUSTRY DEFINED

Structure. The construction industry is a vital component of the U.S. economy employing 6.7 million workersⁱ and accounting for approximately 7.6% of the gross domestic product.ⁱⁱ The construction industry directly supports military operations and readiness and builds the infrastructure for the nation's economy. Construction is a vital component of our nation's economic engine, completing work valued at over \$800 billion per year in the last three years.ⁱⁱⁱ The most significant share of this value is for private residential construction (55%), followed by

public construction (25.6%), and private non-residential construction (19.4%). Military facility construction represents an extremely limited share of the total with just over \$7 billion in 2003.^{iv}

The U.S. construction industry operates in a highly competitive market environment with relatively low capital requirements and barriers to entry and freedom of exit.^v Numerous small firms offer homogeneity of product. Although the large number of firms keeps the industry competitive, the construction market is not characterized by what an economist would call “perfect competition.” Compared to other sectors of U.S. industry, construction companies receive low profit margins. The industry is generally classified into three major divisions, with general building contractors erecting residential, industrial, and commercial buildings, heavy construction contractors building sewers, roads, highways, bridges, and tunnels, and specialty trade contractors providing carpentry, painting, plumbing, and electrical work.

The U.S. construction industry consists of two very different size categories with thousands of small firms and relatively few major firms. More than 97% of the 656,448 construction firms have less than 50 employees, while only 75 companies have more than 1,000 employees.^{vi} Typically, small firms work on small-scale projects while the large firms complete the more complex and expensive projects. As the trend of mergers and acquisitions continues, the U.S. construction industry will consist of even fewer large firms. The largest six firms in the U.S., Bechtel, Fluor, Centex, Turner Corporation, Skanska and Kellogg Brown & Root, account for almost \$42 billion of total revenue.^{vii} This represents a significant increase over last year’s revenue of \$35 billion among the top 6 U.S. firms.

Labor and Employment. The construction industry is one of the largest employers in the U.S., providing work for 6.72 million Americans with a payroll of \$174.2 billion.^{viii} While the rest of the economy struggled to maintain favorable employment numbers, the construction industry gained over 50,000 new jobs in 2003 with 6.7 million total people employed. Nevertheless, the rate of employment growth in the last few years has declined since the brisk industry expansion in the late 1990’s.^{ix} Worker earnings in construction are significantly higher, by 22%, than for other private industries.^x Average hourly earnings of production workers in construction have increased from an annual average of \$14 in 1993 to \$19 in 2004.^{xi} This increased compensation helps compensate for enduring difficult work conditions and is necessary to enable the industry to attract and retain skilled workers in a declining pool. The average weekly hours of production workers in construction is well above the 2003 private industry average of 33.7 for production and non-supervisory workers.^{xii}

Global Construction Market. Like the structure of the industry in the U.S., thousands of small firms and few large firms characterize the global industry structure. The largest market region for international contractors in 2002 was Europe, with firms reporting over \$33 billion in foreign revenue from the region followed by the U.S. and Asia. U.S. corporations accounted for only one of the top 10 international contractors.^{xiii} European contractors dominated this list taking the other nine slots. Two large European firms, Skanska and Hochtief, topped the list largely due to their huge U.S. based subsidiaries. Merger and acquisition activity will continue to have an international focus. Consolidation with U.S. companies allows foreign firms to enter the U.S. market and take advantage of expertise. A large majority of U.S. construction firms are

not publicly traded and therefore are protected against aggressive acquisition. Outside the U.S., foreign contractors often act as subcontractors for U.S. firms and can provide skilled workers at relatively low cost.

U.S. companies account for just over a third of the top 225 international contractors. Only six U.S. companies, Kellogg Brown & Root, Bechtel, Fluor Corp., ABB Lummus Global, Foster Wheeler Ltd., and Jacobs, rank among the largest 25 of international contractors and only four, Bechtel, Fluor Corp., Centex, and Kellogg Brown & Root, are among the top 25 global contractors.^{xiv} U.S. firms are a dominant force in the design business with over half in the top 200 of all international design companies.^{xv} With reported international revenue of \$8.5 billion in 2002, U.S. design firms accounted for over 45 percent of the international market total, primarily from doing work in Europe and Asia. Conversely, foreign design firms realized \$2.7 billion in revenue from work in the U.S. in 2002.

Construction Equipment Industry. The U.S. remains the world leader in the production and export of construction equipment. The overall sales of construction equipment have been declining since 2000.^{xvi} Despite the decline, the industry remains profitable domestically and overseas. The U.S. construction equipment industry retains a decided edge over foreign competitors and has sufficient capability to meet projected short-term national security needs. Japanese companies have perfected the production of highly advanced and dependable construction equipment and this growing capability threatens U.S. supremacy of the market in the long term.

CURRENT CONDITIONS

Domestic Performance. The U.S. construction industry has been showing signs of leveling off after a decade-long overall expansion. U.S. construction growth slowed to about one percent per year in 2002 and 2003 and is expected to stay at that level in 2004.^{xvii} In the cyclical swings of the construction markets, 23 out of the last 36 months have shown positive gains. The cyclical swings in the construction industry transitions have less variance in peaks and valleys in the last few years than during the 1990's. The domestic construction industry is now experiencing a period of flat growth while maintaining historically high contract volume.

A strong home building market, thanks to historically low interest rates, has kept construction growth positive despite a weak overall economy.^{xviii} In 2003, residential building and single-family homes increased by 12% and multifamily unit construction increased by 10%.^{xix} New residential construction in 2003 reached a 25-year high of 1,848,4000 new starts. There are signs this growth trend will not be sustained as residential spending fell 0.3% in January 2004.

Private non-residential spending was relatively flat in 2003 and with shows little hope for gains in the short term with moderately prospects for the future.^{xx} Health and retail building are maintaining modest gains while manufacturing and hotel lodging are moving down. Heavy private construction has been weak in the past three years with few positive signs for significant growth. Public non-residential construction has shown good growth in the last two years,

primarily in educational buildings and highway and road construction. State and local spending accounted for over 80% of public construction.

Profit margins in the construction industry continue to decline based in part on the rising cost of materials and liability insurance. The construction cost index measure increased a full percentage point to 4.4 % largely from rising material and labor costs. Material Cost Index increases continue to concern the industry with the rising costs of steel, lumber, and concrete. The 2004 contract awards forecasts show a small increase for the third consecutive year and a smaller increase in the building cost index softened the impact for the higher materials costs.^{xxi}

International Performance. Construction projects worldwide accounted for over \$3.8 trillion in investment, with over \$100 billion funded for private infrastructure projects.^{xxii} European contractors are the most active in the global market with over 63% of the construction projects by value. The U. S. follows with 16%, Japan with 8%, China with 6%, South America with 1% and the remaining countries with 11%.^{xxiii}

In Asia, China and India dominate the construction market with 9.2% and 10.1% growth respectively.^{xxiv} Fueling some of China's growth is a collateral effect from joining the World Trade Organization (WTO). China's entry into the WTO mandates that it open its construction market to foreign participation, requiring that foreign owned construction enterprises must fund at least 50% or more of the total cost of the contract to gain access into China's exploding market.^{xxv} Although the new rules also allow for joint ventures between foreign and local partners, foreign contractors will no longer be able to work in China by applying for approval on a project-by-project basis.^{xxvi} While the American construction industry thus far has had a limited role in the booming Chinese market, some firms have found opportunities by partnering with local firms or teaming up with European companies.^{xxvii}

Short Term. Projections of a strong overall economic growth of 3-4% growth in 2004 will help the industry continue positive net growth, although certain market segments may see a decline. The U.S. Department of Commerce predicts moderate growth for put-in-place construction up 0.2% in 2004 after 2003's 1.5% increase.^{xxviii} Non-residential building construction is expected to grow slightly faster than most of the industry because many aging industrial plants must be replaced.^{xxix} Residential construction, including single-family housing starts and multifamily structures are expected to perform strongly in 2004 and then erode modestly in 2005 if interest rates rise.^{xxx} Renovations and home improvements will also decline if interest rates rise as expected.^{xxxi} Critical to the health of the housing sector, the Federal Reserve's monetary policy has been a very positive force holding the federal funds rate at 1% to help stimulate the economy, revive the labor market, and prevent deflationary conditions from developing.^{xxxii} Construction of nursing, convalescent homes, health care institutions, and high technology medical facilities and are helping to feed a positive outlook as the industry works to meet the needs of an aging U.S. population.^{xxxiii} Office and manufacturing sectors are showing signs of moderate growth and could help balance the anticipated residential and public slowdown. Heavy construction is projected to increase fueled by needed highway, bridge, and infrastructure repairs.^{xxxiv}

Long Term. The long-term health of the U.S. construction industry appears to be sound. Analysts project a bright long-term outlook for residential construction based on key drivers such as demographic trends and rising per-capita income growth, and increased homeownership among lower-income groups.^{xxxv} Moderate overall growth with isolated pockets of opportunity is projected for other aspects of the domestic market. Domestically, long-term opportunities are projected based on the need to upgrade aging industrial plants, support population growth and changing demographics, and provide facilities for an aging population. Although volume is still at historically high levels, rising costs of materials, supplies and obtaining skilled labor could reduce industry profit margins. Macroeconomic factors such as GDP, employment, and interest rates and policy shifts on the economy and trade will also have an effect on construction activity. Factors that could have a major negative impact include a continuing rise in world oil prices from the high levels of mid-2004, a significant terrorist act in the U.S., and a failure to reduce the federal budget deficit. The increasing globalization of the industry will create competition for supplies and resources and require the industry to increase efficiencies. U.S. industry can take advantage of growing opportunities in the international market to sustain positive growth and maintain profit margins. U.S. firms should be able to capitalize on international trends such as improvements in mortality rates, expansion of energy to rural areas, and infrastructure needs in developing countries. The U.S. Bureau of Labor Statistics projects future job growth in construction to increase by 15% or 21.3 million jobs through 2012.

TRENDS

Infrastructure Privatization. A significant evolution over the past 20 years has been the privatization of public infrastructure construction projects. With strains expected to continue on public budgets, new and innovative private financing options can be a viable option to improve the world's infrastructure. The Department of Defense has been very successful in using privatization to eliminate inadequate housing and improve the quality of family housing.^{xxxvi} California recently approved a \$639 million contract with Macquarie Infrastructure Group to build a toll road between the Mexico border and San Diego as the first project privately funded under the Transportation Infrastructure Finance and Innovation Act.^{xxxvii} The 65-mile, \$3.6 billion Central Texas Turnpike public-private project will allow the state to reduce its use of scarce discretionary highway funds.^{xxxviii} Private investment of public infrastructure is also on the rise in China and Japan. In the \$1.4 billion Hangzhou Bridge public-private venture, the private sector will invest over 50% of the total cost. Thousands of private parties invested over \$24 million to help build the high-speed MAGLEV magnetic train system linking Shanghai and the new international airport. Private investment is so prevalent in Shanghai that it now comprises half of the total infrastructure and over 70% of highway project investment.^{xxxix} To alleviate pressures on public debt, Japan recently approved a plan to privatize construction of over 6,000 miles of expressways through the use of a build, transfer, and operate options.^{xl}

Design Build Project Delivery Method. The design-build method of project delivery has increasingly been the preferred approach for developing and delivering public and private construction projects. The Design-Build Institute of America forecasts that the design-build method will overtake all other project delivery methods in the next few years and level off in the long term. Use of the design –build method has accelerated in U.S. commercial and public

sectors and is now the project delivery method of choice for more than 50 % of non-residential construction in Germany and 70 % in Japan.^{xli} In design-build project delivery a single firm contracts to provide architectural/engineering design services and construction services. Under the traditional design-bid-build method, architects or engineers provide drawings and specifications under a design contract and a separate contract is negotiated with another entity to build the facility. The primary advantages offered by advocates of the design-build method are savings in time and money, better alignment of risk and responsibilities, and increased flexibility in incorporating changes throughout the construction process. Major design-build projects include the light-rail system at Kennedy Airport in New York and the renovation of wedges 2 and 5 of the Pentagon. The Federal Government has turned to the design build method to construct several new U.S. embassies. The U.S. Army Corps of Engineers successfully used this method for several important projects in Afghanistan.^{xlii}

Security Enhancements. Governments and private industries have teamed up to better protect people and property from terrorist attacks. In consonance with the *National Strategy for The Physical Protection of Critical Infrastructures and Key Assets*, Federal agencies, including the Department of State (DoS) and DoD, and local governments and private industries, have upgraded facility construction security standards.^{xliii} The DoS Manual (12FAH-5 H-42) and the draft copy of DoD's building standards establish minimum requirements for physical protection measures. An Interagency Security Committee recently issued security design criteria for new federal office buildings and modernization projects and draft security standards for leased space.^{xliv} The design criteria seek to strengthen buildings to sustain bomb blasts or chemical attacks, through such steps as increasing wall thickness. The new standards also aim to reduce the likelihood of such attacks by requiring facilities to be built on larger compounds with increased setback areas, incorporating better access controls, and enhancing illumination capabilities. Government laboratories are conducting research and development and leveraging old and new construction materials and technologies to meet the challenge of providing better protection for people and facilities. The Federal Government has provided significant funding to enhance security standards in Federal facilities, including an aggressive plan to build and renovate embassies and consular offices worldwide.^{xlv} The seminar found, however, that this commitment is not widespread as local Government and nonpublic customers often lacking the capital and resources needed to incorporate heightened security standards.

Green Building. A significant recent trend in construction has been to promote energy efficiency and minimize environmental impacts in the design, construction, operation, maintenance, and removal of Federal facilities.^{xlvi} A series of Executive Orders requires government agencies to improve energy management, integrate environmental accountability, and incorporate building efficiencies in the design and construction of Federal facilities.^{xlvii} The White House reduced its operating costs by approximately \$300,000 annually using sustainable design methods and the Pentagon renovation project expects to reduce operating costs by \$4 million per year through environmental and efficiency standards. State and local governments are also increasingly requiring compliance with exacting environmental, energy conservation, and building efficiency standards. The green building trend has had a huge impact on new home construction and is changing the way new homes and communities are planned and constructed.^{xlviii}

Information Technology. Historically, the construction industry has been slow to embrace information technology except in the architecture and design sectors. Despite challenges and cultural barriers, the construction industry can improve communication, increase efficiency, and maximize profits through the use of new technology. An essay later in this study explores the growing industry trend in realizing efficiencies through information technology.

GOVERNMENT GOALS AND ROLES

Enhancing the Environment. Federal and state environmental and land use laws and mandates apply from initial project formulation through execution to completion. The National Environmental Policy Act requires an Environmental Impact Statement on proposed major Federal actions significantly affecting the quality of the human environment.^{xlx} The environmental planning and coordination process is intensive and time-consuming, requiring completion of up to 200 major steps and often negotiating overlapping federal and state laws.¹ While these requirements can pose burdens and increase construction project costs, as the Central Artery/Tunnel project in Boston demonstrates, the process can serve to promote national values and community interests.^{li} The Clean Air Act of 1970 is also very important to the construction industry because it links federal highway funding to state compliance with National Air Ambient Quality Standards.^{lii} States not meeting the standards have much more stringent requirements for transportation planning including a comprehensive “transportation conformity” review by EPA.^{liii} Another potential constraint facing developers has been the increase in laws designed to preserve historic properties.^{liv} State and local communities are also becoming more aggressive in efforts to limit burgeoning growth through stricter zoning and land use controls.^{lv}

Federal and State Procurement Mandates. Construction firms interested in doing Federal work must master laws and regulations covering virtually every aspect and phase of contracting and construction.^{lvi} While these mandates further socio-economic interests and increase competition, they often drive up costs and add time to project completion. These mandates significantly effect the industry as about 27 percent of all construction in the U.S. is carried out in the public sector and many private sector construction projects entail governmental financing.^{lvii} The “Buy America Act” requires, with some exceptions, the use of domestic materials in Federal construction contracts.^{lviii} A separate domestic purchase law requires the use of U.S. steel, cement, and manufactured products in Federally-assisted transportation projects.^{lix} Congress will likely maintain, and perhaps even strengthen, Buy America Act requirements as more American jobs are outsourced abroad. Firms doing Federal work can have over 18 separate laws covering their employees.^{lx} The Davis Bacon Act and many state laws require payment of “prevailing local wages” to construction workers.^{lxi} The DoD and many in the construction industry support repealing or modifying the Davis Bacon Act.^{lxii} The Federal Government has been piloting a new procurement method on construction projects consisting of multiple rounds of normally downward bidding. Under this “reverse auction” method, bidders provide a sealed bid and then bid down under a competitive auction. The Association of General Contractors and others in the industry oppose the process and do not believe it guarantees the lowest bid.

Fiscal Policies and Financial Oversight. Through trade and fiscal policies and economic and tax incentives, the Government encourages construction activity and stimulates infrastructure investment. Government tax and spending policies impact the gross domestic, employment, and interest rates and have enormous impact on the industry. Many in the industry believe the 2001-2003 tax cuts helped to stimulate economic expansion that helped fuel a healthy environment for construction. Congressional policies and oversight of the financial sector can also dramatically influence construction activity. Most in the industry support minimal Governmental interference in the financial market. Congress is currently considering legislation to increase the regulation and oversight of the housing-related government-sponsored enterprises (GSEs) Fannie Mae, Freddie Mac and the Federal Home Loan Bank System, that have been under fire following revelations of accounting and management irregularities.^{lxiii}

Trade Policies and Industry Competitiveness The U.S. does not have an integrated policy or a single agency to promote the competitiveness of the construction industry. U.S. embassies often use their good offices to support U.S. firms' efforts in foreign markets. Trade agreements also often include provisions to make U.S. construction firms globally competitive. Agencies such as the EXIM Bank and the Trade Development Program also support the U.S. construction industry overseas. U.S. directors on the international financial institutions, such as the International Monetary Fund and the World Bank, and on multilateral development banks help to ensure that U.S. firms are able to fairly compete in the global construction market. U.S. laws and trade policies designed to assist one sector of industry can adversely affect the construction industry. For example, hefty tariffs imposed by the U.S. Department of Commerce on Canadian lumber imports drive up costs for American homebuilders, who rely on this source of lumber for one-third of its needs.^{lxiv}

Improving Worker Safety. Historically, there has been a high rate of occupational injuries in the construction industry, which ranks behind mining and agriculture for most workplace fatalities and injuries.^{lxv} The injury rate was, however, at an all time low of 4.0% per 100,000 workers in 2003.^{lxvi} The Occupational Safety and Health Administration (OSHA) has played a leading role in improving worker health and safety and reducing accidents in the construction industry.^{lxvii} OSHA will increase enforcement and inspection to improve workplace safety and promote better compliance in areas such as exposure to noise.^{lxviii} In 2003, OSHA published a comprehensive plan addressing ergonomic injuries aimed at developing industry-specific voluntary guidelines.^{lxix} Most construction firms oppose developing an ergonomics standard, claiming they significantly drive up costs. OSHA and EPA are also working on regulatory standards for worker exposure to asbestos.^{lxx}

Funding Infrastructure, Research and Development and Military Construction. Government investments in public infrastructure are crucial to the nation's economic vitality and are needed to maintain military readiness and quality of life for service members. The rising deficit and costs for the War on Terrorism and Iraq reconstruction will reduce funds available for infrastructure needs. The President's 2005 budget reduces Corps of Engineer and Environmental Protection Agency infrastructure spending and calls for freezing highway and mass transit funding.^{lxxi} The 2005 budget-funding request for military family housing is significantly higher,

but the request for other military construction declines.^{lxxii} The budget calls for funding increases for new embassy buildings, airport upgrades, and Veterans' facilities.

Stemming primarily from low profit margins, the construction industry only reinvests 0.5 % of sales in research and development (R&D).^{lxxiii} The Federal Government makes up for this historically low industry investment by providing leadership and funding for construction – related R&D. The U.S. Army Corps of Engineers (USACE) spearheads DoD's R&D, conducting work in such diverse areas as facilities, airfields, protective structures, environmental quality, restoration, conservation, flood control, and climatic conditions. The U.S. Naval Facilities Engineering Service Center also contributes significantly to DoD's construction-related R&D effort. Continued Federal leadership in construction R&D is critical to keeping the industry competitive and efficient. DoD must continue to rely on R&D technological advances to improve the efficiency, security, and durability of military facilities.

Building Codes and Standards. Laws and executive agency rules play an important role in enhancing security standards, increasing energy conservation, and improving the quality of Federal facilities. The National Institute of Standards and Technology is the Federal focal point for promulgation of uniform standards NIST and works with industry to overcome technological hurdles that limit quality and innovation.^{lxxiv} U.S. policy encourages the development and implementation of basic measurement standards to stimulate technological advances, enhance productivity, and facilitate trade.^{lxxv} The Federal Government laboratory provides measurement methods, standards, and associated technologies to improve products and manufacturing processes. State and local Governments adopt codes and standards to promote more effective health, safety, and fire standards for buildings.

MAJOR CHALLENGES

Skilled Labor Shortage. The U.S. construction industry faces a shortage of skilled labor, estimated to exceed 100,000 workers per year.^{lxxvi} The aging workforce coupled with a shortage of young people entering the skilled building trade is threatening the future prosperity of the industry.^{lxxvii} An influx of up to 100,000 new workers is needed to replace older workers and to meet the growing needs of the industry.^{lxxviii} The number of wage and salary jobs in the construction industry is expected to grow about 15% through the year 2012.

Even though the skilled labor shortage has been predicted for a decade, the industry has not acted to stem the problem.^{lxxix} Many secondary schools have phased out industrial arts programs.^{lxxx} In addition, recent studies indicate that new entrants of the construction crafts industry are less likely to remain in the industry through their working life.^{lxxxi} Craft workers are frequently hired for a specific job and laid off upon completion.^{lxxxii} Construction companies are increasingly turning away from skilled union labor in favor of less expensive open shop labor.^{lxxxiii} The number of union workers in the industry has been on a continual decline over the past 20 years, with the percentage of union workers falling from 27.5% to 16.7%. There has also been a dramatic decline in workers completing apprenticeship training for union and open shop programs. Union apprenticeship programs have been more diverse effective in graduating apprentices than open shop programs.^{lxxxiv} New entrants in the construction field, however, have

been increasingly turning to open shop programs that are often shorter and offer better wages and benefits.^{lxxxv} A positive area in the skilled labor market continues to be the large number of Universities offering excellent training for careers in engineering and other construction-related fields.^{lxxxvi}

The potential labor shortage in the U.S is a threat to future economic growth. The construction industry should adopt a long-term approach to recruit, train and retain skilled laborers. The Federal Government can help meet the growing labor demand in the construction industry fund by providing incentives for apprenticeship programs and streamlining the lengthy and cumbersome visa process to help.^{lxxxvii}

Standardized Codes. Building codes provide minimum standards of health and safety by requiring that buildings be designed and constructed to protect persons from injury, death, or substantial damage from fire or structural problems.^{lxxxviii} Independent organizations develop and maintain these codes relying heavily on technical groups such as the American Society of Heating, Refrigeration and Air Conditioning Engineers. Up until 1995, three regional model code organizations and the National Fire Protection Association developed and maintained the codes.^{lxxxix} The codes contain standards in approximately 700 different areas that are typically developed through a consensus process and updated to incorporate new developments in areas such as natural disasters and earthquakes. Model building codes are not enforceable until adopted by states, local jurisdictions, or Federal agencies. The International Building Code, written by the International Code Council, has been adopted in 26 states, the DoD, and many local jurisdictions. Private associations and many in the industry support the adoption of a single national model building code.^{xc}

Declining Infrastructure Funding. Investments in domestic infrastructure, to include rail, mass transit, aviation highways, and water transportation and treatment, directly benefits the U.S. construction industry, fuels the nation's economy, promotes job growth, and enhances quality of life.^{xc} Insufficient and inconsistent funding has caused the aging and overworked infrastructure in this country to worsen. The American Society of Civil Engineers gives the nation's infrastructure an overall rating of D+ and estimates that \$1.6 trillion is needed over the next five years.^{xcii} Infrastructure health is important to our national economy, promotes job growth, and helps fuel home construction. America's transportation infrastructure, including roads, rail, air, and inland waterways is in a dangerous substandard condition. The construction industry supports passage of a robust, six-year transportation bill currently being negotiated in the Congress.^{xciii} A significant dispute between Congress and the Bush Administration over the top line amount may lead to a compromise of extending the 2001 Transportation Equity Act-21. Industry and association officials believe that the failure to enact a new bill would result in \$1.6 billion in project delays and cost more than 20,000 jobs.^{xciv} To meet the infrastructure financing shortfall challenge, the Government and industry must develop innovative financing alternatives, offer increased tax incentives, and establish special purpose corporations.

Liability Insurance. The rising costs and unavailability of liability insurance could have major implications for the health of the industry as firms may be forced to lay off workers, cut worker pay, or join those that have already been forced out of business. The exploding cost of

insurance in the construction industry is a nation wide phenomenon.^{xcv} Managing the high cost of litigation ranks as the highest priority for construction risk managers.^{xcvi} Industry analysts attribute the trend in large part to rising construction defect claims.^{xcvii} The growth in asbestos and mold litigation and claims has led to huge losses for insurers and driven scores of firms into bankruptcy.^{xcviii} The main approach taken by insurers to control losses has been to raise premiums with increases up by almost 60%.^{xcix} Insurers are now avoiding underwriting in more litigious states like New York or California.^c Other steps to minimize risk include incorporating specific exclusions, limiting time for making claims, raising deductible limits, and reducing liability for high damage awards or settlements.^{ci} The construction industry has been forced to respond to the crisis by adopting cost control strategies and finding ways to reduce or shift risk.^{cii} General contractors are filling subcontractor insurance gaps by making subcontractors a named insured and billing them for coverage. Builders are placing clauses in contracts to limit liability, such as precluding claims for defects discovered after a certain time after project completion. One positive development has been a growing recognition among insurance carriers and the construction industry that superior risk management represents a competitive advantage.^{ciii} Congress can help alleviate pressures by enacting class action tort reform and asbestos legislation.^{civ}

Materials Shortages. Over the past year, increases in the prices of steel, copper, nickel, and aluminum, have squeezed already low construction profit margins and complicated effective cost management. An essay below discusses this growing challenge to the construction industry. Exacerbating these material shortages, the construction industry is also facing recent shortages of cement and lumber products.^{cv} These shortages pose a potentially serious threat to short term stability across the industry and will likely lead to price increases for consumers.

ESSAYS

Essay #1. – Information Technology and the U.S. Construction Industry

This essay reviews the construction industry's use of IT and identifies some of the industry leading IT solutions. The use of computers and the internet are increasingly common within the construction workforce, although it lags behind the working population as whole.^{cvi} A Federal study documents an overall trend of improved performance in the construction industry when using information technology.^{cvi} Owners experienced project cost savings of 2.1 percent, and contractors experienced savings of 1.8 percent as D/IT (design/information technology) use increased. There was strong evidence that the use of these technologies also contributed to schedule compression of 5.6 percent for owners and 6.4 percent for contractors.^{cvi}

The use of computer-aided design (CAD) software is arguably the most visible and prevalent use of IT in the entire industry. Software packages like ArchiCAD® from Graphisoft^{cix}, Project 4D from Common Point^{cx}, and Bentley's Architecture Design and MicroStation^{cx} are state-of -art commercial software packages assisting architects and design engineers in capturing requirements, rendering proposals in two and three dimensions, analyzing structures and materials, and generating documentation.

Before any site work can begin there are numerous pre-construction activities that lend themselves to automation support. North American Green[®] offers a software package to address the preliminary requirement to develop mitigation strategies for soil loss. Erosion Control Materials Design Software (ECMDS)^{cxii} does everything from slope and channel protection to vegetation selection and generation of all specifications for the project.^{cxiii} Vulnerability analysis and evacuation planning of structures is another such requirement.^{cxiv} Parsons-Brinkerhoff uses a software program that places simulated people individually inside a CAD rendering of the structure and then directs them to evacuate through the structures' floors and stairwells.^{cxv}

Commercial software packages are available to assist construction firms with many of the responsibilities during the build phase, such as payroll management, project management, supply chain management. Nevertheless, many firms custom design software packages in house. The predominant program management software package of the large firms is Primavera P3e/c[™]. Companies like Dexter & Chaney specialize in construction accounting and human resource software, construction project management software, and document imaging.^{cxvi}

Most COTS applications described thus far have proprietary file formats—storage schemes for the application data. AutoCAD was one of the first widely used CAD programs in the industry. However, the maker, Autodesk, hasn't published the proprietary DWG^{cxvii} file format on which the program is based.^{cxviii} Sending data between programs is problematic if the applications don't know how to read the file format. This is not the only such protocol. Autodesk developed a human readable file format—DXF—which has its own problems of size—2.5 times the size of a DWG file—its not native to the application and therefore an inefficient add-on, it too is not documented therefore translation is unreliable. There are a host of other proprietary as well as standards body approved data standards. FIATECH notes no less than fourteen such standards over half are International Standards Organization (ISO) approved.^{cxix}

To address the issue of multiple standards, like most industries today, the construction industry has turned to eXtensible Markup Language (XML). LandXML is an industry-driven, open XML, non-proprietary-data exchange standard that targets the needs of private and public land development professionals. Ironically, Autodesk initiated the LandXML initiative in late 1999. LandXML version 1.0 was released in June 2002 and has list of government, commercial, and freeware application that are now compatible with the standard. Industry appears to have quietly voted this implementation the defacto industry standard. This will help tremendously with the data-sharing problem of the current state of the practice in the industry.

Many facets of the construction industry can be automated, but there are limits as actual construction can only be automated to a point. Overcoming training, culture, and the challenges of a large and diverse landscape are not insurmountable. Taking a risk to spend money on IT solutions is profit out of the company's pocket. The bigger companies have the flexibility to leverage new technology more quickly than the smaller companies. [Essay by LTC Chuck Hoppe, USA].

Essay #2 –Impact of Material Shortages on the U.S. Construction Industry.

Steel is the backbone of the U.S. construction industry, supplying plate and structural beams needed in most projects.^{cxx} The sharp rise in steel prices in late 2003 and early 2004, up by 6% for reinforcing bars, 10% for plate, and 22% for structural beams, has posed a significant challenges to the U.S. construction industry.^{cxxi} Among the causes underlying the increases is heightened demand from China, growth in the U.S. economy following the 2001 recession, hikes in prices of inputs, and increased transportation costs.^{cxxii} The construction industry consumes 41.5% of all steel produced in the U.S. and for every \$100 rise in the cost of a ton of steel at the mill the total cost of construction increases 3.6% for a steel-frame structure and 3.3% for a concrete-frame structure.^{cxxiii}

This steep increase caught many in the industry unprepared. Price uncertainties make submission of accurate bids on construction projects difficult. Firms are pursuing different strategies to cope with the increased costs, including passing along the increased costs to their customers. Firms with sufficient financial resources are accelerating deliveries to the worksite to avoid having to pay higher prices later or stockpiling to hedge against future price rises.^{cxxiv} Stockpiling provides certainty in material costs to the individual firm but the practice causes supplies to tighten and increases prices and can drive up future handling costs.

The market for steel in the U.S. is not one of “perfect competition.”^{cxxv} The demand for steel is based in large part on the demand for other products such as automobiles, bridges, buildings, railroads, and appliances. As the producers of these products shift their production higher or lower, the demand and the price for steel will rise or fall. Although steel construction materials are relatively homogenous and there are numerous customers, entry into the market as a producer is limited by the enormous capital investments required. Furthermore, because steel customers generally strike individual deals with steel suppliers, there is a lack of transparency in price discovery, which hinders the market’s efficiency.^{cxxvi}

The Administration’s “safeguard” tariff on certain steel products in March 2002 did not help U.S. steel consumers. Imposing the tariff shifted the supply curve up by the amount of the tariff, as high as 30% on some items, thus raising the equilibrium price while lowering quantity. By some estimates, the steel tariffs had cost the U.S. economy about \$980 million and according to a study by the Institute for International Economics for every job the tariffs “saved” in the steel industry, over five jobs were lost in the steel-consuming industries.^{cxxvii} Although economic theory led many to expect that the removal of the tariffs would increase supply and lower prices, a number of other factors overwhelmed these effects. Chief among these factors was the soaring user demand in China, higher mill costs in the U.S. for inputs, such as steel scrap and energy, and panic buying of extra stocks as buyers recognized the beginning of a strong U.S. economic recovery. These upward price pressures were reinforced by an incipient rebound in the manufacturing, nonresidential and heavy construction sectors.^{cxxviii}

To help stabilize the steel market, the U.S. government should send strong signals that it will not intervene in the market again with ill-advised tariffs. Furthermore, the administration should publicly support and encourage the private sector to develop and establish a futures

market for steel, which would have many benefits for the construction industry. A futures market for steel would improve the transparency of the market by allowing for open and public price discovery and provide a cost effective means for firms to hedge against price fluctuations by locking in prices over a longer time horizon. The markets are apparently already moving in this direction.^{cxxix} Efforts to establish a futures market for steel could help minimize price swings by making the price discovery process for steel more transparent. The London Metal Exchange, which already has market for trading aluminum futures contracts, is planning a futures contract for steel that would be targeted at the 60 million metric ton per year market for hot-rolled steel. Each contract would be for five-to-six steel coils each weighing 35,000-45,000 pounds.^{cxix} By making the price discovery of hot-rolled steel more transparent, such a futures market could help to reduce the wild swings in prices that the market often experiences, which would benefit both buyers and sellers.

In addition to steel, the prices for other construction materials have also risen significantly, including hikes in copper, nickel, alumina (for making aluminum), tantalum, molybdenum and coking coal.^{cxix} These increases are significant in the construction industry because it accounts for 40% of the world's copper consumption^{cxix} and 16% of global aluminum consumption. A driving force behind the price increases has been the growing demand from China fueled by its booming economy. China is the world's largest consumer of copper, tin, zinc, platinum and lead.^{cxix} It now consumes 20% of the worlds' copper,^{cxix} 10% of the worlds' nickel,^{cxix} 19% of the worlds' aluminum^{cxix} and 23% of the worlds' tin.^{cxix} These shares are estimated to increase in 2004 and possibly more in 2005.

Factors other than demand from China have caused shortages of copper, nickel and aluminum. The global copper supply was disrupted by a severe landslide in the worlds' largest copper mine in Indonesia and labor strikes in copper mines in Chile. The unprecedented U.S. housing boom also drove up demand for copper with each new home consuming almost 400 pounds of copper.^{cxix}

The expanding use of stainless steel in manufacturing applications replacing ceramic, mild steel, plastics and brass helped increase the worldwide demand for stainless steel. The lack exploration for new sources in the 1990's and lower than expected output capacity of new mines combined to keep nickel supplies down.^{cxix} As a result, nickel reserves are extremely low and production from new mines or reopened old mines will not compensate for current demand until after 2006.

Although aluminum shows a modest increase in price by comparison, the storm is just around the corner. Alumina, the raw ingredient refined to make aluminum, is in short supply. Alumina prices over the past year have double from \$230 to \$450 per ton.^{cxl} It will not be long before aluminum reserves hit low ordering points and this significant price increase will be passed on to the consumer. In the mean time, China is expanding its smelting production with the aid of U. S. Aluminum giant Alcoa. The shortage of alumina for smelting will exist through 2006, which will limit the increase of worldwide production of aluminum to no more than 6%. Meanwhile, China's demand for aluminum in 2004 alone is expected to increase 19%. Other factors that will likely increase the demand include the expansion of aluminum as an alternate

resource for steel and a vibrant U.S. residential housing market.

Cost of construction to the consumer and maintaining the builder's profit margin are the immediate concerns. From a financial aspect, many current residential building contracts do not have a contingency for increased material costs. Consequently, the homebuyer frequently pays the bill for the increased material costs. A bigger concern for building material shortages in residential projects is project delay. Additionally, material shortages that lead to delays will amplify cost overruns. Fortunately, with the exception of steel, the impact due to copper, aluminum and nickel shortages on construction projects has been minimal. However, with reserves getting alarmingly low and with the raw material shortage forecasted to extend at least another two years, increased customer, homebuyer and taxpayer costs are inevitable. [Essay by Harold Foster, DoS, and CAPT William Drake, USN].

Essay #3 – Iraqi and Afghanistan Reconstruction Challenges

The massive reconstruction needs in Afghanistan and Iraq and construction requirements for supporting deployed U.S. and coalition forces has tested the construction industry's surge capacity, flexibility, and capability. The industry's performance, often under hostile conditions, has ably demonstrated it is able to support high tempo military operations and to respond to significant increase in national security needs. Iraq's uncertain security and political environment has, however, limited participation to large construction firms capable of absorbing large costs and risks.

The Coalition Provisional Authority's Program Management Office (PMO) oversees the \$18.4 billion appropriated by Congress to support the reconstruction of Iraqi infrastructure. The U.S. Agency for International Development (USAID) and DoD are the primary agencies issuing contracts on behalf of the PMO. Since April 2004, approximately \$8 billion (a total of 31 contracts) of the \$18.4 billion appropriated by Congress has been contracted out. The work covers significant Iraq infrastructure projects in the areas of communications; electrical; public buildings; transportation; public works; and security.^{cxli}

The security of personnel, infrastructure, and vehicle convoys has been a continual challenge. A large number of foreign contractors and Iraqis working for foreign companies have been killed in Iraq since major combat ended in May 2003. The unstable security environment in Iraq has made it very difficult to obtain insurance for people and equipment working in Iraq. To cover employees, American companies must purchase expensive Defense Base Act coverage, costing up to \$30 per \$100 of payroll. Foreign companies purchase similarly expensive insurance for their workers through such firms as Lloyds of London. To adequately protect against other risks in the hostile environment, companies must purchase insurance for equipment losses, political risk, and contract frustration. A lack of affordable insurance has discouraged companies from bidding on Iraqi construction contracts. As a result, only a handful of large companies bid on each of the fifteen reconstruction contracts awarded by the Coalition Provisional Authority (CPA). Although there are many other factors limiting the ability of companies to bid on Iraqi construction contracts, uncertain security and high insurance costs reduce competition. The Federal Government could increase competition by agreeing to

indemnify U.S. contractors for losses incurred through hostile action. Building a better security environment would also promote greater domestic and international firm involvement.

Task Force Restore Iraqi Oil (RIO) is an excellent example of industry partnering with a military organization to accomplish a critical mission. Under USACE oversight, U.S. and Iraqi civilian contract personnel, military personnel, Federal civilian employees and third country and Iraqi Nationals are working to restore Iraq oil production system to prewar status. This mission is critical to Iraq's future as oil underpins the nation's entire economy by providing 95% of its foreign earnings. Through RIO's efforts, two million barrels of oil now flow from Iraq's wells.

The USACE established a provisional command, the Gulf Region Division, in January 2004 to provide battle command to USACE elements in support of Operation Iraqi Freedom and engineering support to the CPA and CJTF-7. The Division has assumed all functions performed by the RIO. Three subordinate districts under the Division work infrastructure issues throughout Iraq including electricity, oil, public works, water, security, transportation, communication, building, housing, and health projects.

During the last decade the military services have significantly expanded reliance on civilian contractors to support military operations. This trend has accelerated during Operation Iraqi Freedom. The Army established the Logistics Civil Augmentation Program (LOGCAP) in 1992 to rely on civilian contractors to provide support and augment the logistics requirements of deployed forces. In 2001, the Army awarded through a competitive bid a 10-year task-order contract with a 1-year base period and nine 1-year options to Halliburton Kellogg Brown and Root (KBR). The contract requires KBR to deploy within 72 hours of notification and to deliver combat support and combat service support. The Army uses KBR to provide for the construction of base camps, including billeting, dining facilities, water, and sanitation systems, and other logistics support.^{cxlii} The Army has awarded KBR more than \$2 billion in Iraq-related work under LOGCAP's expense plus a profit contract.^{cxliii} Some Members of Congress question the Iraqi contracting process and allege that the "cost-plus" contracting method increases costs, hinders performance, and results in waste, fraud and abuse.^{cxliv}

There are concerns about using contractors to support military operations in a war zone. Over reliance on contractors could eventually degrade the wartime construction competencies of engineer units. The unavailability of contractors to perform in uncertain security environments can also adversely effect military operations.

The Air Force uses organic military Prime BEEF and RED HORSE heavy repair units to conduct Air Force bed down requirements. When augmentation is required, the Air Force uses more than one contractor to perform Air Force Contract Augmentation Program type work, even within the same theater. In January 2002, the Air Force awarded Readiness Management Support (RMS) a \$450 million eight-year contract. The Air Force also has a contract with DynCorp to maintain war reserves in Oman, Qatar, and Kuwait for a period of seven-years at a cost of \$30 million. The Air Force uses AFCAP to provide engineering experts and special power and construction equipment and supplies. For example, the Air Force relied on RMS to provide concrete paving support to help complete an airway runway project ahead of schedule.

Major construction projects, such as restoring a country's oil industry, rebuilding an electrical grid system for an entire nation, should be completed by large and experienced construction contractors. Military engineer units should be primary method, however, for performing local civic projects that build goodwill between military and local civilian populations. Engineering support directly to the war fighting force in an operational theater should be the responsibility of experienced military engineer units such as Army Engineers, Air Force Prime BEEF or RED HORSE units, and Navy Seabees.

Another aspect of construction in Iraq is the construction of base camps and facilities to support deployed U.S. and coalition forces. Although this is a small element of the construction industry, it has important implications for troop morale and military effectiveness. Since the end of the Cold War, the U.S. military has shifted from fixed base to contingency base operations to support expeditionary operations. This was especially true in Operation Enduring Freedom in Afghanistan and Operation Iraqi Freedom. Both the Army and the Air Force are working to capture the lessons learned from base camp construction in Afghanistan, Kuwait, and Iraq to provide better life support to our soldiers and allies. Both Army and Air Force engineer units use prepositioned assets to build camps. In selecting base camp locations, DoD engineers seek to capitalize on the use of existing facilities and infrastructure if possible. Security is a major consideration when identifying locations and building base camps, and camp engineers must plan for the security of contracted construction personnel.

Because civilian contractors are often unable to respond quickly, DoD should rely on organic military construction engineers to establish base camps. These engineers should be deployed with the lead security elements. [Essay by COL Tori Bruzese, USA; COL Miro Kurka, USA; and Lt Col Maria Dowling, USAF]

IMPLICATIONS FOR NATIONAL SECURITY

The U.S. construction industry plays a vitally important role in national security. The industry empowers America's influence in the global community and supports the sustainment of the armed forces during long-term conflict. The impressive response by the construction industry to rebuild the World Trade Center and restore Iraq infrastructure clearly demonstrates that U.S. construction firms can surge quickly and effectively.

While there are no significant concerns about the readiness of the construction industry to contribute to national security, some challenges are on the horizon. Rising costs to support the War on Terrorism and Iraq could impose financial constraints for funding necessary military construction projects and public infrastructure upgrades critical to ensuring the military can mobilize when needed. Shortages and increased demands for critical materials could impact the readiness of the industry to support military needs. The Government can, however use the Defense Production Act and other authorities to help ensure that critical materials and equipment are dedicated to meeting national security and civil emergency requirements.^{cxlv} The industry's labor shortages could also impact future readiness and may require Federal intervention to attract young people to enter and stay in this important industry.

POLICY RECOMMENDATIONS

- Congress should enact asbestos and class action tort reform to achieve marketplace efficiency and fairly assign risks.
- State and Federal Governments should maintain funding outlays for public infrastructure projects and enact tax and trade policies to promote investment and business development.
- Congress should provide financial assistance for apprentice-training programs and
- initiate immigration reforms to address the skilled labor shortage.
- The U.S. government should encourage the private sector to develop a futures market and resist tariffs or price controls on steel.
- State and local jurisdictions should adopt uniform codes and standards.
- Military construction units, and not civilian contractors, should be used to build base camps and perform minor reconstruction efforts.

CONCLUSIONS

After five months of intense industry study, to include research, lecture, discussions, and observation, the seminar concludes that the U.S. construction industry is poised to remain a cornerstone of our economy and a vital contributor to our national security. As demonstrated in recent military operations and reconstruction efforts in Afghanistan and Iraq, the industry is capable of mobilizing and supporting national security objectives.

The construction industry is one of the largest and most diverse industries in the U.S. The economic expansion experienced over the past 20 years coupled with the housing market boom during the past decade has boosted the construction industry portion of the nation's labor force. The short-term and long-term outlook for the industry remains positive, with best prospects for growth in the international sector. Factors that could have a major negative influence on future growth include a continued upward spiral in the federal budget deficit, rising world oil prices, and a major terrorist attack in the U.S.

Despite positive economic performance, the industry must adapt to confront challenges such as a shortage of skilled craft workers, increased competition from international firms, constrained capital funding, and rising costs for materials and liability insurance. Federal, state and local governments must collaborate with industry to provide the significant capital investment needed to improve and maintain the infrastructure necessary to support the nation's economic engine, support the military, and maintain a high standard of living. Government oversight has largely had a positive effect on the industry, especially in the areas of improving building quality, worker safety, and environmental protection. Government policies should be carefully crafted to improve the global competitiveness of U.S. industry. Proper management of exchange markets and monetary policies and minimal interference from federal banking regulators will be critical in sustaining continued growth. Jurisdictions should adopt uniform codes and standards and revise the standards to incorporate technological developments.



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ⁱ U.S. Department of Labor, *Industry at a Glance: Construction*, <http://www.bls.gov/iag/iaghome.htm>.

ⁱⁱ U.S. Census Bureau, *Census of Construction*, U.S. Department of Commerce, 1997. Census statistics are taken every five years with the 1997 figures still the most current available.

ⁱⁱⁱ U.S. Census Bureau, C30 series, *Value of Construction Put in Place*, May 2003, p.13. The latest figures show construction put in place at 868.8 billion per year in 2002.

^{iv} Randy Giggard, *Construction Outlook*, Third Quarter 2003 Report, FMI, p. 12.

^v Contractors tend to have relatively little fixed overhead. Most of their workforce is in the field on projects, not in offices. Workers are hired and let go as needed. Rather than buy large pieces of equipment, contractors often rent equipment on an as-needed basis. A 1997 Standard & Poor's survey of 5,214 construction companies found that only 50 of them (1%) had assets of more than \$50 million. Some 58% of the companies had assets of \$500,000 to \$5 million.

^{vi} U.S. Census Bureau, *Census of Construction*, U.S. Department of Commerce, 1997

^{vii} The Top 400 Contractors, *Engineering News Record*, September 2003, p. 11.

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^{ix} *Construction Facts – Employment Growth is leveling Off*, *Engineering News Record*, November 2003, p. 62.

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^{xi} AGC, Data Digest, Vol. 4, Feb. 2-6, 2004. Figures based on constant 2003 dollars. Hours of production for workers in the industry have been steady over the 1993 to 2002 period, never below 38.4 and never above 39.2.

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^{xiii} The top 225 International contractors, *Engineering News Record*, August 2003, p. 36, http://enr.construction.com/people/topLists/topIntlCont/topIntlCont_1-50.asp.

^{xiv} Reina, Peter, with Tulacz, Gary J., *Global Construction Sourcebook*, *Engineering News Record*, New York: January 5, 2004. Vol. 252, No. 1, pp. 22 & 30. European firms

dominate the top 25 positions in both the international and global contractor lists, with 16 and 12 firms respectively. Japan's five largest contractors (Kajima Corp., Taisei Corp., Shimizu Corp., Obayashi Corp., and Takenaka Corp.) were also among the top ten global contractors in 2002

^{xv} Reina, Peter, with Tulacz, Gary J., *Global Construction Sourcebook*, Engineering News-Record, New York: January 5, 2004. Vol. 252, No. 1, pg. 8.

^{xvi} *Construction Facts - Equipment Sales Decline*, Engineering News-Record, November 2003, p. 62.

^{xvii} *Ibid.*, pg. 75.

^{xviii} *Construction Facts - Economics*, Engineering News Record, November 2003, p. 54. Private nonresidential growth followed single digit declines of -4.7% in 2003 and -18.4% in 2002.

^{xix} National Association of Homebuilders Newsletter, January 28 2004, <http://www.nahbmonday.com/eyeonecon/issues/2004-01-28.html>.

^{xx} Private non-residential spending was relatively flat over 2003. There has been no apparent clear upturn that has taken place. Nonresidential construction continues to be the responsible sector for weakness in construction spending. Nearly all categories of private construction spending fell in January. Spending on lodging fell 4.1%, office building fell 5.2% and commercial construction dropped 2.6%. Communications, power and manufacturing were the only three sectors of nonresidential categories to post small increases.

^{xxi} Engineering News-Record, *Economics*, March 2004.

^{xxiii} The American firm Lockwood Greene (which was acquired by Colorado-based CH2M Hill Cos. in December 2003 from the J.A. Jones bankruptcy) teamed up with the Dutch design firm Tebodin BV to land a major auto plant contract for BMW in Shenyang, China. The Dutch firm brought its relationship with BMW to the deal and the American firm contributed its expertise and presence in China. Tulacz, Gary J., *Work Abroad Is No Longer a Safe Refuge from Soft Local Markets*, Engineering News-Record, New York: April 21, 2003, Vol. 250, No. 15, pg. 79.

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^{xxxi} *NAHB’s Eye on the Economy*, National Association of Home Builders, Washington D.C. March 10, 2004. <http://www.nahbmonday.com/eyeonecon/issues/2004-03-10.html>.

^{xxxii} *NAHB’s Eye on the Economy*, National Association of Home Builders, Washington D.C. April 21, 2004. <http://www.nahbmonday.com/eyeonecon/issues/2004-04-21.html>

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xliv Silver, Elaine, *Design-Builders Pass Muster in Afghanistan*, Design Build, September 2003, p. 17.

xlvi http://www.dhs.gov/interweb/assetlibrary/Physical_Strategy.pdf

xlvii After the Oklahoma City bombing in 1995, President Clinton directed the Department of Justice to assess the vulnerability of federal office buildings to attack, which resulted in a 1995 report entitled *Vulnerability Assessments of Federal Facilities*. The study designated five separate levels of security needs depending on the number of federal employees housed in the facility and the responsibilities of the agency.

xlviii After the bombing of the American embassies in East Africa, the Secretary of State formed the Overseas Presence Advisory Panel to study vulnerabilities in current and future embassies and consulates. *America's Overseas Presence in the 21st Century*, The Report of the Overseas Presence Advisory Panel, Department of State, November 1999. Page 4. The study recommended an investment of \$1.3 billion annually for enhancements.

xlix Energy Policy and Conservation Act (42 U.S.C. 6361(a)(1); the Resource Conservation and Recovery Act of 1976 (42 U.S.C. 6901, et seq.); and the National Energy Conservation Policy Act 42 U.S.C. 8253, 8262g, and 8287 require federal agencies to implement programs to reduce energy consumption in federal facilities.

l Executive Order 11912 of April 13, 1976, Delegations of Authority under the Energy Policy and Conservation Act. Executive Order 13123 of June 3, 1999, *Greening the Government through Efficient Energy Management*; and Executive Order 13221 of July 31, 2001, *Energy-Efficient Standby Power Devices*. Executive Order 12780, *Federal Agency Recycling and the Council on Federal Recycling and Procurement Policy*. In 1998, President Clinton issued Executive Order 13101, *Greening the Government*

Through Waste Prevention, Recycling and Federal Acquisition, which built on previous executive orders and created the White House Task Force on Waste Prevention and Recycling. Executive Order 12852 established the President's Council on Sustainable Development, recommending 140 actions to improve the nation's environment, many related to building sustainability. Executive Order 12123 (June 3, 1999) encourages government agencies to improve energy management and reduce emissions in Federal buildings through better design, construction, and operation. Executive Order, 13148 (April 21, 2000) charges Federal agencies to integrate environmental accountability into decision-making and long-term planning. Executive Order 12902, Energy Efficiency and Water Conservation at Federal Facilities, requires that appropriate consideration be given to building efficiencies in the design and construction of Federal facilities and Executive Order 13123, Greening the Government Through Efficient Energy Management. The Office of the Federal Environmental Executive monitors Federal compliance with the executive orders and oversees the "green building" initiatives. For a general discussion and history see, *A Brief History of Green Building*, Building Design and Construction, November 2003 and *Federal Commitment to Green Building: Experiences and Expectations*, http://www.ofee.gov/sb/fgb_report.html.

^{xlvi} For an overview of this trend in the residential field see, *Building Greener: Building Better: The Quiet Revolution*, The National Association of Homebuilders, 2002, http://www.nahb.org/publication_details.aspx?sectionID=702&publicationID=17

^{xlix} 42 U.S.C. 4321-4347. The Act is the basic national charter for protecting of the environment and is triggered in the construction planning process when federal funds are used to finance a project. NEPA created the Council on Environmental Quality (CEQ). The CEQ regulations implementing NEPA are at 40 C.F.R. §§ 1501.6 & 1508.5.

¹ According to a recent report by the General Accounting Office, as many as 200 major steps must take place in the NEPA process to construct a new major federally funded highway project taking between nine and 19 years to complete. Over 15 states have NEPA equivalent laws. For a list of the states and citations, consult the EPA website at <http://ceq.eh.doe.gov/nepa/regs/states/states.cfm>. Agencies such as the U.S. Army Corps of Engineers (Corps) (for wetland and water permits), the U.S. Fish and Wildlife Service (for Endangered Species Act compliance), the Advisory Council on Historic Preservation (for historic preservation laws), the EPA and many other agencies are commonly involved in this process. Executive Order 12114 creates similar environmental impact analysis requirements for major federal actions outside the U.S.

^{li} See Hughes, Thomas, *Rescuing Prometheus*, Pantheon Books, 1998, Chapter V – Coping with Complexity: Central Artery/Tunnel, pp. 197-254. During the lengthy public comment and approval process, project officials made numerous changes to address agency feedback and community concerns covering matters ranging from air, water, and soil pollution to wetlands, vegetation, wildlife, appearance, noise, and vibration. Developers also agreed to take 1,100 mitigatory measures to offset environmental impacts, adding \$2.8 billion to the project cost. The CA/T EIS process was not entirely

free of problems, however, as environmental and community activists used the process to delay the project and extort mitigation measures from developers.

^{lii} 42 U.S.C. 7401. The Act authorizes the Environmental Protection Agency (EPA) to set national standards for pollutants that may cause adverse effects to health and the environment. Winston, Sherrie, *Clean Air Case Clouds Project*, Engineering News Record, Vol. 242, Issue 20, May 24, 1999, p. 14.

^{liii} The transportation compliance process can impose additional costs and delays on projects and is often used by environmental groups to block or delay transportation projects. Because they could delay transportation developments, the construction industry is concerned about any action to tighten national ambient air quality standards, such as the 1997 EPA action to strengthen rules for coarse particulate matter. See, Engineering News Record, July 7, 1997, p. 8. The 1998 Transportation Reauthorization Act directed the Department of Transportation to develop a coordinated environmental review process for highway construction projects. Section 1309 of TEA-21 calls for all environmental reviews, analyses, and permits to be conducted under a mutually agreed upon schedule by both federal and state agencies with jurisdiction over the project.

^{liv} The National Historic Preservation Act of 1966 requires completion of an archaeological assessment on Federal projects to determine if there will be an adverse affect on historic property. The National Historic Preservation Act Amendments of 1980 require that "prior to the approval of any Federal affecting a property which is on the World Heritage List or on the applicable country's equivalent of the National Register, the head of Federal agency having direct or indirect jurisdiction over such undertaking shall take into account the effect of the undertaking on such property for purposes of avoiding or mitigating any adverse impacts. The Advisory Council on Historic Properties publishes an advisory guideline to assist Federal agencies with real property management responsibilities in preparing the assessments and reports. <http://www.achp.gov/PA-EOguidelines.html>. See also Executive Order 13287, "Preserve America."

^{lv} For example, Portland, Oregon, adopted an Urban Growth Boundary in 1979. The initiative has become a very contentious political issue, and has caused significant increases in home prices. Land use laws have major implications on the construction industry, particularly the residential housing sector.

^{lvi} A recent study prepared for GSA identified 28 federal mandates and 7 executive orders that had to be considered on federal construction projects. The General Service Administration's General Reference Guide for Real Property Policy lists the laws and executive orders that affect design, construction, and leasing of Federal property. In comparing state and federal courthouse construction costs, the study estimated that these mandates added an average \$4.04 per square foot to the cost of a federal courthouse.

^{lvii} Richard Vedder and Lowell Galloway, *Wages, Profits and Minority Business, Society*, Vol. 37, Issue 1, November/December 1999, p. 86.

^{lviii} 41 U.S.C. 10a - 10d. This law is implemented by Defense Federal Acquisition Regulation Supplement (DFARS) Subpart 225.7002

^{lix} The Surface Transportation Assistance Act of 1982. Similarly the Berry Amendment requires the DoD to buy certain products essential to military readiness with 100% U.S. content and labor, such as clothing and other textile items, specialty steel, and food. 10 U.S.C. section 2533a (2000); see also DFARS 225.7002-1(a) (1 July 2002)

^{lx} *A Closer Look: Construction, Safety and Health*, Vol. 167, Issue 5, May 2003. The Department of Labor has established a computer websites to assist employers in determining the labor laws that apply to the firm. Among the laws that could apply are the Contract Work Hours and Safety Standards Act; the Davis-Bacon and Related Acts; the Fair Labor Standards Act; The Family and Medical Leave Act, 29 U.S.C. 2601; the Immigration and Nationality Act, 8 U.S.C. 1101; Labor-Management Reporting and Disclosure Act; the McNamara-O'Hara Service Contract Act, 41 U.S.C. 351; the Occupational Safety and Health Act; the Rehabilitation Act of 1973; Uniformed Services Employment and Reemployment Rights Act; Vietnam Era Veterans' Readjustment Assistance Act; the Walsh-Healey Public Contracts Act, 41 U.S.C. 35; Worker Adjustment and Retraining Notification Act, 29 U.S.C. 2101

^{lxi} Service employees in the industry, such as architects and engineers, are subject to a separate prevailing wage standard pursuant to requirements of the Service Contract Act of 1965. 41 U.S.C. 351 et seq. and 29 Code of Federal Regulations 4.101 et. seq. "Prevailing wages" have been consistently interpreted as meaning the scale paid to unionized workers. Under a formula promulgated by the Department of Labor, the 30% rule defined the term "prevailing wage rate." In 1979, despite opposition from labor unions, the 30% rule was changed to a 50% rule in an attempt to reduce construction costs for government contracts. Wall Street Journal, *Davis Bacon Meets Jim Crow*, May 22 1992, pg A-1. Thieblot, Armand J., *A New Evaluation of Impacts of Prevailing Wage Law Repeal*, Journal of Labor Research 17 (Spring 1996) 297-322.

^{lxii} Schooner, Steven, *Employee Relations Law Journal*, Spring 1985, Volume 10, Issue 4, Anonymous, *In Search of a Cure for Davis Bacon*, Nations Business, July 1981, Vol. 69, Issue. 7, p. 60. The Congressional Budget Office estimates that Davis-Bacon adds \$9.6 billion over 10 years. See Human Voice, *Senate Votes to Keep Davis Bacon Wages for Disaster Areas*, Vol. 55, Issue 39, October 22, 1999, p. 23.

^{lxiii} S. 1508, the "Federal Housing Enterprise Regulatory Reform Act of 2004" was approved by the Senate Banking Committee in April 2004.

^{lxiv} Simon, Bernard, *Canada Split on Lumber Fight with the United States*, New York Times, December 19, 2003, p. W-1. The tariff is intended to offset the benefits to

Canadian sawmills of the low fees charged by the provincial governments to harvest trees in state-owned forests.

^{lxv} Martin V. Green, and Karen Gaspers, *OSHA's Top 10*, Safety and Health, Vol. 166, Issue 6, December 2002, p. 26. Construction workers are twice as likely as the average worker to be killed by a motor vehicle, and 40% of worker fatalities from motor vehicle accidents are pedestrians. Laborers and operating engineers accounted for nearly half of the machine-related deaths. Alice H. Suter, *Construction Noise: Exposure, Effects and the Potential for Remediation*, AIHA Journal, Vol. 63, Issue 6, Nov/Dec 2002, pg. 768. Construction lost more workers to traumatic injury death than any other major industrial sector during 1980 through 1995. The leading causes of death among construction workers are falls from elevations, motor vehicle crashes, electrocution, machines, and struck by falling objects. Approximately 1,200 fatalities per year in construction from four leading hazards: falls from elevation, electrocutions, struck-by equipment or falling objects, and caught by or in between equipment, trenches.

^{lxvi} In 2002, the rate of deaths from injuries in construction per 100,000 full-time workers was approximately 14. Ironworkers account for a rate nearly six times higher than all other construction occupations. Martin V. Green, and Karen Gaspers, *OSHA's Top 10*, Safety and Health, Vol. 166, Issue 6, December 2002, p. 26.

^{lxvii} Occupational Safety and Health Act, 29 U.S.C. 651 and implemented under 29 Code of Federal Regulations, Part 1926.60. OSHA standards for construction are specialized in some areas but the requirements medical and exposure records, personal protective equipment, and hazard communication are similar to those applicable other sectors. As with many industries, nonfatal injury and illness data are grossly underreported, in part because companies trying to avoid an increase in workers' compensation premiums and desire to maintain a good safety record

^{lxviii} Henshaw, *OSHA to Increase Construction Enforcement*, Safety and Health, Vol. 167, Issue 4, May 2003. The National Institute of Occupational Health and Safety and the NIOSH, a Department of Health and Human Services agency, provide research, information, education, and training in occupational safety and health. NIOSH works to prevent work-related illness, injury, disability, and death by gathering information, conducting scientific research, and translating the knowledge gained into products and services.

^{lxix} In 2003, OSHA published a comprehensive plan to address musculo-skeletal disorders or ergonomic injuries for general industry aimed at devising industry specific voluntary guidelines. In 2000, OSHA published mandatory regulations but the Congress moved to pass S.J. Res. 6 to overturn the ergonomics rule. Congress has been considering legislation to require OSHA to promulgate mandatory rules.

^{lxx} For example, OSHA has added education and training programs and established a Construction Directorate to provide more specific construction expertise. *OSHA May Be*

Getting Better as Knowledge Comes With Age, Engineering Record, Volume 247, Issue 1, July 2, 2001. Some industry officials argue that labor leaders use OSHA as an organizing tool and some competitors use the agency to damage their competitors.

^{lxxi} <http://www.whitehouse.gov/omb/budget/fy2005/defense.html>. Ichniowski, Tom, *Bush Budget Cuts or Freezes Most Programs*, Engineering News Record, February 9, 2004, p. 9.

^{lxxii} Military construction expenditures for 2002 and 2003 were \$5,405 million and \$6,505 million respectively. The budget for 2004 for military construction is \$5,452 million. The 2005 President's budget requests \$5,288 million.
<http://www.whitehouse.gov/omb/budget/fy2005/defense.html>

^{lxxiii} According to the Civil Engineering Research Foundation. This figure is extremely low compared to other industries.

^{lxxiv} The National Institute of Standards and Technology, a non-regulatory agency of the U.S. Department of Commerce, strengthens U.S. global economic competitiveness by developing technologies, measurement methods, and standards.
http://www.nist.gov/public_affairs/industry.htm

^{lxxv} Congress enacted the National Institute of Standard and Technology Act, 15 U.S.C. 271. Executive Order 12770, *Metric Usage in Federal Programs*, requires that the metric system of measurement be implemented in all new federal design and construction projects.

^{lxxvi} Mazzullo, Lainie, *Construction Industry Targets Education Programs to Stem Worker Shortage*, Wichita Business Journal, Jan 18, 2002. The Construction Labor Research Council report estimates the need for new trade workers to be in excess of 100,000 per year and that number could be significantly higher. *Report Confirms Personnel Shortage in Construction Field*, Pride of St. Louis, Inc., May 16, 2002.

^{lxxvii} Adbol Chini, *Causes of the Construction Killed Labor Shortage and Proposed Solutions*, ASC Proceedings of the 35th Annual Conference, April 7, 1999. According to the Bureau of Labor Statistics, between 1984 and 1993, the number of men, ages 55 to 61, who continued to work while receiving pensions rose from 37% to 50%.

^{lxxviii} Testimony of Tery R Yellig, Partner of Sherman, Dunn, Chen Leifer and Yellig, P.C. before the House Education and the Workforce Oversight and Investigations Job Opportunities in Construction, 21 July 1999.

^{lxxix} Spencer, Barbara, *Shortage of Older Construction Labor Pool*, Apartment Association, April 20, 2001.

^{lxxx} Mazzullo, Lainie, *Construction Industry Targets Education Programs to Stem Worker Shortage*, Wichita Business Journal, Jan 18, 2002. According to Corey Peterson, Executive Vice President of the Associated General Contractors of Kansas.

^{lxxxix} Spencer, Barbara, *Shortage of Older Construction Labor Pool*, ApmrntAssociation.com, April 20, 2001.

^{lxxxii} Chini, Adbol, *The Construction Labor Shortage and Proposed Solutions*, ASC Proceedings of the 35th Annual Conference, April 7, 1999.

^{lxxxiii} Grant Thornton, *Contractor Emphasizes Importance of Training*, GT Online Industries, September 4, 1998.

^{lxxxiv} Biginsoy, Cihan, *Report-Apprenticeship Training in the U.S. Construction Industry*, University of Utah, Department of Economics, September 1998, p. 13.

^{lxxxv} Barrett, Rick, *Building a Better Image*, Milwaukee Journal Sentinel, December 9, 2001.

^{lxxxvi} *Construction Facts*, Engineering News Record, November 2003.

^{lxxxvii} The U.S. Bureau of Labor Statistics recently estimated that more than 2 million workers will be needed in construction trades and related fields between 2000 and 2010 due to job growth and net replacements for retiring workers. Senate Foreign Relations Committee, Hearing on U.S. Mexico Relations, April 16, 2002. The Bush Administration initiated a temporary worker program in January 2004 to allow undocumented workers an opportunity to qualify for a temporary work permit. As the program would change existing immigration laws, Congressional action will be necessary to make fully implement the program.

^{lxxxviii} NFPA 5000(TM), Building Construction and Safety Code(TM), in Section 4.1.1 Jerry Wooldridge, Examining the Philosophy of Building Codes, Vol. 98, Issue 1, January /February 2004, page 30

^{lxxxix} Rosta, Paul, *California's Adoption of New Standard Creates Controversy*, Engineering News Recors, Vol. 251, Issue 11, September 15, 2003.

^{xc} The National Association of Home Builders, for example, has been active in efforts to promote uniformity and fairness of codes and standards.
<http://www.nahb.org/page.aspx/category/sectionID=224>

^{xci} The Association of General Contractors of America predicts that for each additional \$1 billion in the signed bill, 47,500 construction jobs are created for one year.

^{xcii} American Society of Civil Engineers, “Report Card for Americas Infrastructure”
<http://www.asce.org/reportcard/>

^{xciii} The six-year highway and transit programs reauthorization legislation (H.R. 3550, S. 1072) has been stalled in Congress lawmakers negotiate the overall funding level. The Bush administration supports a \$275 billion funding level while the Senate approved a \$318 billion level in S.1072.

^{xciv} Heavens, Alan, *A Decaying Foundation*, The Philadelphia Enquirer, p. 1.

^{xcv} Meg Green, *A Hole in the Wall*, Best Review, July 2003, p.51. Rates in California, Nevada, Colorado, the Carolinas and Florida have risen most.

^{xcvi} *Construction Industry Managers Weigh Risks*, Civil Engineering, Volume 65, Issue 10, October 1995, p.18.

^{xcvii} DePadgua, Antonio, *Crush of Defect Claims Persist in Construction Insurance Market*, National Underwriter, Volume 108, Issue 4, February 2, 2004, p. 18.
Construction defect claims are difficult to manage because contractors can be held liable years after completing a job or for loss or damage not due to their negligence.

^{xcviii} Mark A. Hofman, *Jobs Hurt by Tort System Woes*, Business Insurance, Volume 38, Issue 38, March 8, 2004. p. 4. A recent RAND study reports that 600,000 people in the U.S. have filed claims for asbestos-related injuries, costing businesses more than \$54 billion. RAND Publication, *Asbestos Litigation Costs and Compensation: An Interim Report*, <http://www.rand.org/news/press.02/asbestos.html>. The study reports that 500,000 to 2.4 million more claims could be filed in the years ahead, costing businesses as much as \$210 billion more.

^{xcix} Korman, Richard, and Tony Illia, Tony, *Rising Prices, Shrinking Policies Generate Waves of Uncertainty*, Engineering News-Record, Vol. 252 Issue 4, January 26, 2004, p. 4. Umbrella liability coverage has been a particularly problematic market, challenging the many contractors relying on this insurance to provide protection above limits in other policies. Fletcher, Meg, *Builders Finding a Tough Market for Umbrella Cover*, Business Insurance, Vol. 37, Issue 48, December 1, 2003.

^c Hickman, Ann Rudd, *Carriers Cut Back Coverage for Construction Defects*, American Agent and Broker, Issue 7, Volume 75, July 2003, p. 24.

^{ci} Korman, Richard and Illia, Tony, *Rising Prices, Shrinking Policies Generate Waves of Uncertainty*, Engineering News-Record, 1/26/2004, Vol. 252 Issue 4, January 26, 2004, p. 4.

^{cii} The complexity of risk in the construction industry is unrivaled in other industries. The complicated chain of contractual liability connecting owner, general contractor, design

professionals, and subcontractors makes the fair and efficient assignment of risk, liability, and costs a staggering challenge.

^{ciii} The International Risk Management Institute presents practical strategies and tactics to assist industry and insurance professionals to identify risks identification, adopt controls, and finance alternatives. <http://www.irmi.com/expert/>.

^{civ} Congress has considered several bills to accomplish tort reform. Legislation modifying class action lawsuit jurisdiction has the best chance of passage (S. 274). Congress has also been considering legislation to address asbestos litigation to reduce litigation risks for the industry but the prospects for enactment this year appear slight.

^{cv} Carlton, James, *U.S. Cement Shortage Spreads*, The Wall Street Journal, May 20, 2004, p. A-2.

^{cvi} National Institute of Standards, Department of Commerce, *Impacts of Design/Information Technology on Building and Industry Projects*, Washington, 2001, p. 21-24.

^{cvi} National Institute of Standards, Department of Commerce, *Impacts of Design/Information Technology on Building and Industry Projects*, Washington, 2001, 21-24. The research focused on four key design/information technology technologies: bar coding, integrated databases, 3D CAD (computer-aided design) systems, and EDI (electronic data interchange).

^{cvi} National Institute of Standards, Department of Commerce, *Impacts of Design/Information Technology on Building and Industry Projects*, Washington, 2001, p. 21-24.

^{cix} <http://www.graphisoft.com/products/archicad>

^{cx} <http://www.commonpointinc.com/products/brochures/Project4DBrochure.pdf>

^{cx} <http://www.bentley.com>

^{cxii} *Erosion Control Program is a Steal*, Engineering News Record, May 20, 2002.

^{cxiii} <http://www.nagreen.com/software>

^{cxiv} *Researchers Model Bio-Attack Flows*, Engineering News Record, January 28, 2002. The Department of Energy's Scandia National Laboratories developed a modeling and simulation tool to assess the vulnerability of buildings to chemical and biological attacks. KCNBC, as the model is known, uses the buildings CAD drawings as the foundation of the simulation.

^{cxv} Sawyer, Tom, “*Emergency Planning*,” *Engineering News Record*, July 22, 2002. The software is produced by Integrated Environmental Solutions, Ltd. Of Glasgow, Scotland.

^{cxvi} <http://www.dexterchaney.com/dc/110271.html>

^{cxvii} DWG is an undocumented format that was the native format of Interact, a CAD program written in the late 1970s which Autodesk licensed and upon which AutoCAD is based. Autodesk has controlled and updated the DWG format from its founding as a company. Source: The Open Design Alliance web page: <http://www.mps.com>.

^{cxviii} Tuchman, Janice, *Bentley Pushes File Format*, *Engineering News Record*, June 2, 2003.

^{cxix} Testa, Nichole, *Data Standards and Open Systems*, *FIATECH*, <http://www.fiatech.org/projects/idim/default.htm>

^{cxx} *Time for Big Steel to Deal with Endless Cycles of Crisis*, *Engineering-News Record*, September 30, 2002, Vol. 249, No. 14, p. 60.

^{cxxi} Haughey, Jim, *Soaring Steel Prices Halt, But Remain High*, *Building Design and Construction*, March 1, 2004, p. 9. The March 1, 2004, issue of *Building Design and Construction* reported these figures.

^{cxxii} Haughey, Jim, “*Soaring Steel Prices Halt, But Remain High*,” *Building Design and Construction*, March 1, 2004, p. 9.

^{cxxiii} Grogan, Tim, *Higher Steel Prices Could Push Overall Building Costs Up 8%*, *Engineering-News Record*, April 5, 2004, <http://enr.constuction.com/news/bizlabor/archives/040405.asp>

^{cxxiv} Cancelada, Gregory, Leiser, Ken, Naudi, Jack, and Feldstein, Mary Jo, *Steel Prices Push Up Building Costs; China's Growth Pulls Supplies From U.S.*, *St. Louis Post-Dispatch*, February 27, 2004, p. C1.

^{cxxv} In a perfect market based economic system, consumer demands and production costs allocate resources automatically and anonymously. In general, when prices accurately reflect resource scarcity and economic actors are aware of those prices, market-based economies will allocate resources efficiently.

^{cxxvi} Tejada, Carlos, *Steel Tariffs Resist An Easy Solution; Gathering Reliable Data On Labor-Market Impact Is Proving to Be Difficult*, *The Wall Street Journal*, November 17, 2003, p. A2.

^{cxxvii} King, Neil, Miller, Ken, and Tejada, Carlos, *U.S. Steel Tariffs Ruled Illegal, Sparking Potential Trade War, WTO Rejects U.S. Appeal; Hot Issue for White House as EU Promises Retaliation*, The Wall Street Journal, November 11, 2003, p. A1.

^{cxxviii} Haughey, Jim, *Soaring Steel Prices Halt, But Remain High*, Building Design and Construction, March 1, 2004, p. 9.

^{cxxix} Glader, Paul, *Some Groups Weigh Creation of Steel Futures and Indexes*, The Wall Street Journal, April 1, 2004, p. C3. This article reports that the Multi Commodity Exchange in India launched trading in steel futures in March 2004 and that the London Metal Exchange and New York Mercantile Exchange were both looking into offering steel futures contracts.

^{cxix} *U.S. Steel Importers Warm to LME plan for Steel Futures*, Platt's Metals Week, November 24, 2003, Vol. 74, No. 47, p. 13.

^{cxxxi} To gain perspective of the magnitude of price increases, the following statistics display a sampling of construction related raw material price changes from 2003-2004.

Material	Price March 2003 \$US/Ton	Price March 2004 \$US/Ton	Percent Increase 2003-2004
Copper	1,587	3,098	95%
Nickel	7,940	13,930	75%
Aluminum	1,350	1,663	23%
Tin	4,510	8,405	86%

London Metal Exchange and Authors Calculations, *Daily LME official offer prices for 2003/2004*. Online, London Metal Exchange, <http://www.lme.co.uk/dataprices/historical.asp>.

^{cxxxii} Bloomberg News, *U.S. Home Building Cements Demand for Copper*, March 18, 2004.

^{cxxxiii} Samuelson, Robert, *Great Wall of Unknowns*, The Washington Post, May 24, 2004, p. 12. Based on Asian Development Bank's annual economic report.

^{cxxxiv} Soros, G., *China Commodity War in Raw Materials*, February 25, 2004, Marketocracy. Internet.
<http://www.marketocracy.com/cgin/WebObjects/Portfolio.woa/ps/ReadTopicPage/source=GdOhBlAiEaDnDaDaMaKiAbDc>.

^{cxxxv} Falconbridge LTD, *Strength in Nickel*, 2003, Falconbridge, Internet.
http://www.shareholder.com/falconbridge/downloads/Falco_nickel_strength_2003Eng.pdf.

^{xxxxvi} *China is Draining Global Commodities*, 15 March 2004, Online. Daily Express News, Malaysia, <http://www.dailyexpress.com.my/news.cfm?NewsID=25466>.

^{xxxxvii} United States Geological Survey, *Mineral Industry Surveys—Tin in September 2003*, December 2003, U.S. Geological Survey, <http://minerals.usgs.gov/minerals/pubs/commodity/tin/snmis0903.pdf>.

^{xxxxviii} Bloomberg News, *U.S. Home Building Cements Demand for Copper*, March 18, 2004. Online. Australian Financial News. <http://afr.com/articles/2004/03/17/1079199289652.html>.

^{xxxxix} Hasselback, Drew, *World Nickel Shortage Looms as Price Soars: Rationing Possible as Current Supply Lags Demand*, March 11, 2004, National Post's Financial Post & FP Investing, Canada, LexisNexis. http://web.lexis-nexis.com/universe/document?_m=36800bace82070e42d310b3dcf121dcd&_docnum=1&wchp=dGLbVlz-zSkVA&_md5=e5cc668a43f2aa3d7b5abace7845e9bd.

^{cxl} Xiao Yu, *Alcoa to Get China's Go-ahead on Aluminum Tie-up*, March 5, 2004, Bloomberg.Com. Internet. http://quote.bloomberg.com/apps/news?pid=10000080&sid=apQtmQwgs_BI&refer=asia.

^{cxli} The website www.rebuilding-iraq.net shows the projects assigned to construction contractors.

^{cxlii} Army Awards LOGCAP III Award, *Army Logistician*, March/April 2002, Vol. 34, Iss. 2.

^{cxliii} Spinner, Jackie, *Army May Allow Some Bids for Some KBR Work*, *Washington Post*, March 19, 2004, p. E-02.

^{cxliv} Representative Henry Waxman (D-CA) has been the most outspoken critic of the Iraq LOGCAP contracts. His website includes a compilation of the investigations and allegations concerning the LOGCAP contracts, <http://www.house.gov/waxman/>

^{cxlv} Enacted originally in 1950, the Act provides tools to ensure adequate and timely delivery of materials needed for national security or in cases of national emergency. This authority has been used to maintain domestic production in industries dominated by foreign companies where markets are too small to otherwise sustain an upstart company. Title I of the Defense Production Act provides the President the authority to require preferential performance on contracts and orders, as necessary, to meet national defense and emergency preparedness program requirements.

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